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## Rare event risk and emerging market debt with heterogeneous beliefs



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In a setting where the lender and the borrower have heterogeneous beliefs about the likelihood of a disastrous shock to the borrower's economy, we study the debt contract that defaults at the occurrence of that shock, as proposed by Barro (2006). We find that a higher belief by the lender compared to the borrower can lead to countercyclical interest rates and credit spreads in non-default times, and to an increase in the borrower's indebtedness in default times, as often observed in emerging market economies. When calibrating the model to prices in the credit default swap market, we show that heterogeneous beliefs can account for more than 40% of the variation in CDS spreads associated with shocks to the borrower's economy in non-default times.

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### 1. Introduction

Emerging market economies are often subject to rare event risk which can severely affect their aggregate output. Examples include tsunamis, drought, terrorism, war, or political instability. Such rare events are not fully predictable, and it seems plausible that a country's debt contains insurance against adverse economic conditions through write-downs. As studied by Barro (2006), disasters are often associated with partial default, forced conversion of debt into illiquid instruments, or the depreciation of debt through high inflation. In this paper, we study the equilibrium pricing of a debt contract when a borrower's economy is subject to such rare event risk. Barro (2006) allows for default at the occurrence

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of a rare event and studies the default's impact on the equity premium. However, default also implies the existence of a default premium implicit in the interest rate, which is the focus of our paper.

Our dynamic model captures an additional imperfection. Namely, the borrower and the lender might not agree on the likelihood of a rare event and the subsequent default. While this is a natural assumption given that the true frequency of rare events is unknown or difficult to estimate, it could also be seen as the outcome of additional market frictions, such as informational asymmetries, absence of a bankruptcy code, or different political systems. For example, Calvo and Mendoza (2000a, b) suggest a scenario where globalization promotes contagion among emerging market economies, and investors can become overly pessimistic about economies, even those that are not directly related to the cause of the crisis. More specifically, we introduce this form of heterogeneity to the levered economy studied in Section III of Barro (2006). While he assumes full participation of the borrower and the lender in the equity market of the economy, we find it useful to tailor the problem to emerging market economies, in which lenders do not necessarily participate directly in the borrower's equity share. Instead investment in the borrower's economy typically occurs through a debt contract. We fully specify all equilibrium dynamics in terms of economic fundamentals, in particular the rate of interest, the write-off (recovery rate), the credit spread, and the default risk premium. We find implications along several dimensions during normal economic times as well as during default times.

First, we find that the debt's interest rate is decreasing in the belief of the lender, and increasing in the belief of the borrower. The impact of heterogeneity can be large enough such that the borrower is willing to pay an interest rate to the lender which is significantly higher than the fundamental's growth rate. Both directions are linked to the endogeneity of the write-off on the debt contract. The write-off is increasing in the belief of the lender, but decreasing in the belief of the borrower.

Second, our model delivers strong effects on variability and covariation in normal economic times. It generates stochastic interest rates, credit spreads, and risk premia, with equilibrium volatilities possibly several times higher than under homogeneity. Surprisingly, interest rates can also exhibit countercyclical behavior in normal economic times. This can occur when the lender anticipates a higher rare event likelihood as compared to the borrower. The finding is surprising, as a benchmark model under no rare event risk or homogeneity in beliefs would deliver procyclicality. The countercyclical interest rate is consistent with empirical findings by Neumeier and Perri (2005), who document a negative correlation between output and real interest rates for several less developed economies. While Neumeier and Perri (2005) provide an explanation based on a small open economy model subject to factor productivity shocks, international interest rates, and country risk, to our knowledge, our paper is the first to show that leverage and heterogeneous beliefs can contribute to this phenomenon.

A feature of the model is that all frictions are embedded in one state variable having the interpretation of the borrower's leverage ratio. In related work, Edwards (1984) shows the significance of several variables, including a country's indebtedness, to explain the level of the sovereign yield spread of less-developed countries between 1976 and 1980. Boehmer and Megginson (1990) find support that liquidity or solvency factors can explain the price dynamics for syndicated loans of less developed countries between 1985 and 1988. Similarly, Claessens and Pennacchi (1996) provide a model for the pricing of Brady bonds between 1990 and 1995, in which a state variable captures the country's ability to repay. All of these studies support our approach, but the dynamic nature of our solvency state variable arises *endogenously*, which in turn determines the variation and covariation of the interest rate.

A novel prediction that arises from our model concerns the change of the borrower's indebtedness during default times. The scenario that also supports countercyclicality in non-default times, i.e. a higher belief by the lender compared to the borrower, predicts that the borrower's indebtedness should increase at default. This should happen since the more cautious lender is only willing to accept a write-off value lower than the shock to the borrower's output process. Interestingly, this prediction is empirically confirmed by Benjamin and Wright (2009), showing that the average country exits default with a debt to GDP ratio 25% higher than before entering default.

We calibrate our model to prices observed in the credit default swap market of eight emerging market countries. Confirming Uribe and Yue (2006) for our data, we find that the borrower's economic fundamentals have explanatory power for CDS spreads above and beyond the state of the world economy or exchange rate fluctuations. We discipline the model by assigning historical values of output volatility, leverage ratios, and default intensities, and show that the model can not only deliver

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